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Lack of Women in STEM: Competence or Confidence?

An Examination into Gender Differences in Ability and Attitudes at Primary School Level

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Abstract

The primary focus of the current research was to investigate abilities in spatial awareness tasks and attitudes towards mathematics in primary school aged children and how these factors may relate to later Science, Technology, Engineering and Mathematics (STEM) involvement. A cohort of 97 primary school aged children (43 males: 54 females) completed two spatial ability tasks, testing both 2D and 3D rotation with animate and inanimate stimuli and a modified version of the Attitudes towards Mathematics Index (ATMI). Children's job aspirations, parent's occupations, individual teacher identification and gender were collected for secondary analysis. No significant gender differences were found for spatial awareness tasks in either accuracy or reaction times; however, there were significant differences in overall and individual attitude factors. Significant gender divide became apparent at Primary 7. Significant decreases in girl's attitudes in individual factors were noted from Primary 3. This study adds to research suggesting no biological male advantage for mental rotation. However, stark gender differences in attitudes towards mathematics are clear. Results suggest intervention methods for both mathematics and wider STEM participation are required in lower primary school. Significant results for parents and teachers suggest further research, including media stereotypes and portrayal of women in science, is required.

Keywords: mathematics attitudes, spatial ability, mental rotation, STEM, gender disparity

Lack of Women in STEM: Competence or Confidence?

An Examination into Gender Differences in Attitudes and Ability at Primary School Level

There is a well-documented gender disparity in the representation of women in the fields of science, technology, engineering and mathematics (STEM). Despite the significant advances in female representation across STEM fields over the past 30 years, gender equality in these fields is far from achieved. The path from primary school through to a STEM career has often been referred to as a 'leaky pipeline' (e.g. Metcalf, 2010). The 'leaky pipeline' metaphor suggests that as the career path progresses, a greater ratio of females to males drop out of STEM. Theoretically, as we increase intervention in STEM, female representation within those fields should also increase and gender disparity should level at each stage of the STEM career path. However, figures from the past year show that the opposite is occurring. Statistics from Women in Science, Technology, Engineering and Mathematics (WISE) for 2016 show the depletion of women at each stage of the pipeline. While mathematics and (at least) one science is compulsory within the British education system, girls outperform boys across STEM – 71.3% of girls achieving A* - C grades at GSCE compared to 62.4% of boys. Despite this, only 18% of girls continue from GCSE onto A-Level exams and subsequently, only 25% of UK undergraduate degrees in STEM fields are obtained by women. Numbers of women in technology and computer science are particularly low at only 14%. In contrast, women are in the majority for medical and biological sciences, making up 70% of the graduates. Despite the number of women in STEM increasing by 13,000 in the past year, the proportion of female workers has dropped from 22 to 21%. In Engineering, women make up only 8% of the work force, a drop in over 5,000 employees. At board level, only half of the 48 STEM companies listed on the FTSE 100 have 2 or more female directors on the board and less than 1/3 of the directors are female. While these numbers are progress, the path towards gender equality in STEM has a long way to go. A plethora of reasons have been suggested for the continuing gender gap. At the core, there are two key issues: ability in STEM subjects and attitudes towards STEM. It is also important to address factors which contribute to children's attitudes: teachers, parents and wider societal values.

Gender Disparity in Mathematic Abilities

Mathematics is a core skill that permeates STEM success (Blackley & Howell, 2015). Given that success and enjoyment within mathematics is key for STEM involvement (Hill, Corbett & Rose, 2010), it is important to first consider abilities and attitudes within mathematics prior to wider STEM participation. In addition, mathematics has been identified as the critical filter in accessing higher paid positions and positions of prestige (Perl, 1982), and so research into mathematics abilities and attitudes not only feeds into STEM representation, but also the wider issue of gender pay gap across the workforce.

Reilly, Neumann and Andrew's (2015) extensive meta-analysis explored mathematics achievement throughout the education system. Children were tested in grades 4, 8 and 12 from 1990 to 2011. Overall, over 2 million students were part of the subject pool. Examinations were split into 5 core mathematic skills: number properties, geometry, measurement, data analysis and algebra. Their results showed that males outperformed females in all areas. These findings are consistent with previous studies that suggest while there is no direct gender difference in IQ, males have significantly higher performance in mathematical reasoning (i.e. Hyde, Fennema & Lamon, 1990; Geary, Saults, Liu & Hoard, 2000). However, studies into mathematic performance (and associated skill sets) fail to account for attitudes towards the subjects in question, or the impact of mathematics anxiety. Mathematics anxiety is an anxious state where self-esteem is perceived to be threatened due to mathematics-related environments and situations (Cemen, 1987). The assumption is that children with higher test anxiety are less likely to perform to their full potential. Females may be more prone to mathematics anxiety due to negative associations between their ability and performance in this subject (Devine et al, 2012). Ma (1999) conducted a meta-analysis of 26 cross-cultural studies examining the relationship between mathematic anxiety and mathematic achievement. The meta-analysis spanned studies from 1978 through to 1992 with a total of 18,279 participants ranging from ages 5 – 12. Significant effects for anxiety ($r = -.27$) were noted. This research is correlational, and so no causal implication of anxiety on performance can be implied purely from this data. However, these results have been replicated in numerous studies since that suggest anxiety is a significant predictor of mathematic performance, particularly for girls (Hill et al, 2016; Stoet, Bailey, Moore & Geary, 2016; Cargnelutti, Tomasetto & Passolunghi, 2017).

Individual abilities in mathematics varies from child to child. However, the evidence for wider gender disparity in mathematics performance is varied. Given that studies of this nature often fail to report on mathematics anxiety as a mediatory factor, it is possible that the differences in scores are not related to innate mathematic ability, but are a result of poor confidence in abilities which impacts performance levels.

Spatial Abilities

STEM, particularly engineering, success relies heavily on spatial reasoning and mental rotation (Wai, Lubinski & Benbow, 2009). Spatial reasoning has been repeatedly shown to be a significant predictor of mathematic success in primary school aged children, particularly within mental rotation paradigms (Zhang, Koponen & Rasanen, 2014; Tosto et al, 2014). Casey et al. (2015) notes that a number of studies relate spatial ability to early mathematic skill. The study hypothesised a path model whereby spatial ability acts as a potential mediator between ability and performance in mathematics. They tested 127 girls in both 1st and again in 5th grade in a longitudinal study, finding that not only does spatial ability relate to mathematic reasoning, but also is a significant predictor of analytic reasoning later in schooling. As spatial ability is an accurate predictor of mathematic ability, it also may provide a measure of testing mathematics without children being aware of its mathematic quality. In this, it is less likely to be confounded by measures of mathematics anxiety. However, spatial ability is another area of cognitive performance that has consistently shown male advantage (Linn & Petersen, 1985; Sanders, Soares and D'Aquila, 1982).

Patterns of male favoured performance in mental rotation could be as a result of biologically innate, cognitive superiority in these types of task (Levine et al. 2016). Evolutionary psychologists suggest that male superiority in spatial awareness tasks is due to necessity for navigation during times of hunting and gathering (Gaulin & Fitzgerald, 1986). Neuburger, Jansen, Heil and Quaiser-Pohl (2011) tested both 2nd and 4th grade children in mental rotation, finding a significant gender difference in performance at 2nd grade level, but not at the 4th grade level. They suggest that this result could be a result of hormonal shifts between these ages, in line with findings from Hampson (1990) that suggests higher oestrogen levels may inhibit spatial abilities. However, more recent research suggests that the gender gap is closing, if it is there at all, and can be reduced through spatial abilities training (Cheng & Mix, 2014).

Spatial awareness and mental rotation performance could be linked to exposure and practice. Oostermeijer, Boonen and Jolles (2014) showed that constructive play (i.e. jigsaw puzzles and blocks) is a significant predictor of later mathematic reasoning abilities. If spatial ability is indeed a mediator, exposure to play activities that hone these skills could be a contributing factor to superior test scores for both spatial abilities and mathematics, as seen repeatedly in cognitive testing of males. Societally, boys are given toys that require spatial rotation and understanding, such as blocks or Lego, whereas girls are typically more likely to be exposed to animals and people (Schug, 2016). Ruthsatz, Neuburger, Jansen and Quaiser-Pohl (2015) tested mental rotation in children by splitting stimuli into gender stereotyped groups. They hypothesised that boys would perform better on male orientated stimuli (i.e. trains and cars), and that girls would perform better on female orientated stimuli (i.e. dolls and teapots). Findings suggested that there was a relationship between familiarity and performance, as supported by spatial training tasks (Uttal et al, 2013) but no significant effect of stimulus type in performance. They did note that, overall, all students performed worse in the male stimulus than the female stimulus. This could be a result of stimulus intricacy, rather than adhering to stereotype bias. Animate stimulus (e.g. stimulus that had faces) were more prevalent in the female orientated stimulus and could provide an explanation as to why performance was higher across all subjects in this category. If exposure to stimulus benefits performance in spatial ability tasks, traditional tasks (such as the Mental Rotation Task (Vandenberg & Kuse, 1978) of block rotation may have a male bias. Therefore, it is important to test stimulus that accounts for stimulus type and bias. By doing this, the current study will not only determine whether there is a gender disparity seen in spatial awareness tasks generally, but will also test whether stimulus type influences performance.

Gender Disparity in Mathematic Attitudes

Halpern et al (2007) noted that girls have a more negative attitude towards mathematics that increases throughout time within education. Since the early 1970s, gender disparity in attitudes towards mathematics has been a topic of research due to the implications towards STEM involvement and subsequent employment. While it is well documented that there is a gender disparity in mathematics attitudes, it is unclear at what age this disparity occurs and which areas of mathematics attitudes are most effected.

Accessing accurate representations of children's attitudes towards any subject area can be challenging, particularly considering power relations and experimenter bias (Harris et al, 2015). Larkin & Jorgensen (2016) tested primary school aged children recorded video diaries documenting their attitudes towards mathematics. 105 students took part over a ten-week period from 4 different classes. Qualitative analysis of key words throughout the video diaries and excerpts were analysed - incorporating information from interviews with the children themselves, their teachers and their guardians. Given the videos were privately recorded, it is suggested that this method allowed for more honest attitudes. Generally, the attitudes tended to be more negative for girls, but focused more on boredom and frustration rather than misunderstanding of the mathematic concepts themselves. While this study highlights the problem of poor mathematic attitude in individual settings, it does not give us a clear picture on a national level. Unfried, Faber & Wiebe (2014) aggregated quantitative resources from across the United States of America to look at attitudes towards STEM in both elementary and middle school aged children. A similar pattern of decline was found in this cohort, however no significant differences for mathematics were found, the significant effects were only seen in engineering and technology. This is particularly interesting as alternative research suggests that poor mathematics attitudes can disadvantage girls as early as preschool (Geist, 2015).

Mathematics attitudes encompass a number of different factors. As previously discussed, mathematics anxiety is often focussed on as it has been shown to mediate performance (Ganley & Vasilyeva, 2014), however there are a number of other factors to consider when assessing overall attitudes. It has been suggested that STEM have been considered abstract and lacking societal benefit by women (Ceci & Williams, 2011; Spelke, 2005). Given this, it is important to consider how relevant children believe mathematics to be for wider society and for later employment. In conjunction with mathematics anxiety, confidence in abilities has also been shown to hinder performance and has been linked more readily to girls (Voyer & Voyer, 2014). As outlined in Larkin & Jorgensen's study, the negative attitudes displayed by girls focussed on boredom and frustration. It is necessary to consider mathematics enjoyment and effort, as motivation in any subject is linked with higher success (Van Lange, Rekers-Mombarg & Dekkers, 2006). Analysis of factors is key in understanding what motivates gender disparity in attitudes. Disparity in specific factors may precede overall gender disparity in attitudes, in which case identifying these differences will influence the route and course of teaching and intervention.

As shown from the research outlined above, it is well-documented that girls have more negative attitudes towards mathematics. However, whether these attitudes are present throughout primary school has yet to be determined, or indeed where the significant difference occurs while considering various factors within mathematics attitudes themselves such as enjoyment, motivation, effort and wider relevance. The underlying reasons for gender disparity in this field are uncertain. Given this, when studying children's attitudes towards mathematics: anonymous, individual questionnaires that test factors of mathematic attitudes are required. Individual teacher identification and parents' current career have also been collected. While this study does not suggest that these are the only factors relevant in contributing to children's attitudes towards mathematics, it is important to determine whether individual teacher (and by extension – individual teaching practices) significantly influence attitudes. In addition, by assessing parents' current career this study aims to encompass the potential effect of positive role models within STEM and parent's positive attitudes towards STEM.

Current Study

As outlined above, the previous research tends to focus on STEM success from high school onwards, and the implications of STEM attitudes once women are in STEM fields. While each of these areas are key in our understanding of gender disparity, this paper argues that previous research often does not look early enough, and is too segmented.

This study aims to further identify whether a gender difference in innate ability exists, while exploring whether there are differences seen between different types of spatial ability stimulus. Children will be presented with stimulus of both blocks and teddy bears, to provide stimulus that is both animate and inanimate, with the assumption that there should be no gender bias towards perception of teddy bears. It has been clearly identified in previous research that there is a gender disparity in attitudes towards STEM; however, it is yet to be seen at what age this disparity occurs, and which areas of these attitudes see gender difference. Children will fill out an anonymous questionnaire that assesses the four aforementioned factors that contribute to mathematics to help clarify which sections of mathematics attitude show gender disparity and at which age. Additionally, this study will improve understanding into the additional factors that may influence attitudes towards STEM by assessing the role of individual teachers, and parents' occupations.

Given the wide inclusion criteria and number of potential influences that need to be examined in this area, the current study acts as a pilot study for a wider STEM inclusion project in Primary School aged children across Scotland. Understanding how each of the factors contribute to STEM involvement will allow for further investigation into each area with greater clarity as to their influence. By running this as a pilot study, the aim is to identify whether gender differences are apparent in either ability or attitude for STEM, what age they become apparent, and identify factors that may contribute to STEM success to provide a more direct approach for future study.

Research Questions & Hypotheses

The current study has two primary research questions. Firstly, to determine whether there is a gender difference in spatial ability tasks at any age throughout primary school aged children. It is hypothesised that there will be no gender difference shown at any age group. Secondly, to determine whether there is a gender difference in attitudes towards mathematics at any age throughout primary school aged children. It is hypothesised that there will be a gender difference shown; however; it is unclear at what age this difference will occur. In addition to these primary questions, there are 3 subsequent research questions that will be considered. Firstly, whether there will be any differences in ability between the two tasks between genders. Given the previous research into practice effect, it is hypothesised that there may be a male advantage for the traditional block task but there will be no difference between genders for the bear task. Secondly, to explore whether ability in spatial awareness tasks predicts attitudes towards mathematics. Finally, to identify whether individual teachers and parent's occupations are predictors of children's attitudes towards mathematics. Given that the research into this is sporadic, particularly at this age group, both of these research questions are purely exploratory.

Methods

Participants

A total of 97 children from Primary 1 (7 males: 16 females, *M* = 5;10, *SD* = 0;3.5, range = 5;6 – 6;4), Primary 3 (11 males: 10 females, *M* = 7;10, *SD* = 0;3, range = 7;5 – 8;4), Primary 5 (14 males: 18 females, *M* = 9;10, *SD* = 0;3.5, range = 9;3 – 10;4), and Primary 7 (9 males: 11 females, *M* = 11;10, *SD* = 0;4.5, range = 10;10 – 12;6), were randomly selected from a primary school in the Scottish Borders. While a non-binary option was available, no participants identified as such, and so gender was only recorded as male or female. All children were native English speakers.

Materials

Computer-based mental rotation tasks displayed three shapes simultaneously on the screen. Stimuli in one task were 3D shapes, in the other task stimuli were teddy bears. Children were instructed to match either the left or right stimulus to the target in the middle by pressing one of two keys on a keyboard. Stimuli were rotated in 30° increments. Equal numbers of trials were presented on the left and right sides in random order. Given the wide age range of the participants, separate difficulty levels were presented for each age group to limit the likelihood of a ceiling effect. In the shape trials the target and distractor shapes differed by only one cube and a higher degree of rotation differentiating initial prime and intended target shape for the older age group. In the bear trials the younger age group saw the bear only with head facing forward, the older group bears heads were either facing left or right. The experimental procedure included practice items (8 trials) and experimental trials (72 trials). The percentage of correct items and the mean response time were recorded.

The questionnaire was adapted from the Attitudes towards Mathematics Index (ATMI). The ATMI includes 40 items (10 of which are negatively worded) with 4 subscales: self-confidence (15 items), value (10 items), enjoyment (10 items) and motivation (5 items) (Tapia & Marsh, 2004 for current version). Items were assembled using Likert-scale format, responses ranging from strongly agree (5) to strongly disagree (1). The questionnaire was rewritten in more suitable vocabulary and with greater relevance for primary school aged children (see Appendix A). Pilot testing confirmed that the modified questionnaire appropriately matched factor loading of the original questionnaire. At the end of the questionnaire children were also asked what occupation they aspired to when they left school, and was later coded as “STEM”, “Life Sciences” or “Non-STEM” for further analysis. All children were provided with a coding sheet that showed number values, faces and descriptions to help them complete the questionnaire appropriately.

Further information obtained for each child were instances of additional learning requirements, parent's occupations (coded as "STEM", "Life Sciences", "Non-STEM", "Stay at Home/Retired" and "Absent/Unknown"), teacher's gender, and individual teacher identification. Options for parents' occupations were given as caregiver 1 and caregiver 2 for inclusivity, but every participant responded with both mother and father's occupation and so separate variables for mother and father's occupations were recorded.

Procedure

The experimenter conducted trials with children individually at their school in one session that lasted approximately 20 minutes. Trials were completed in an empty classroom. The experimenter followed a predetermined script explaining to each child that they would take part in two short games and would be asked some questions at the end. Children were told they were playing a game to limit test anxiety effects where possible. Children were randomly assigned to seeing the block task or the bear task first. Questionnaires were always carried out after tasks were completed. In the two older age groups questionnaires were completed in groups of 5 – 10 children, the younger age groups completed questionnaires one-to-one to provide help with reading and to clarify that the children understood all the vocabulary.

Permission to test in the school was given by the head teacher. Information sheets and full consent forms were provided to parents before testing. Verbal consent was also obtained from the child before each session. Ethics for the project was approved by the Psychology Research Ethics Committee at the University of Edinburgh.

Design

The experiment used a 4x2 between subjects design. The independent variables were age (5, 7, 9 and 11 year old) and gender (male and female).

Results

Gender Differences in Ability

As spatial ability tasks were collected as percentage data, log transformations were conducted on accuracy measures for both block and bear tasks. Descriptive analyses (see Figure 1) and density plots reveals large left skew despite this transformation, and so outliers greater than 2.96 standard deviations of the mean were removed. Given this data cleaning, 92 observations remained for the block task and 93 observations remained for the bear task. Means table has been provided (Table 1) detailing raw percentage means and standard deviations.

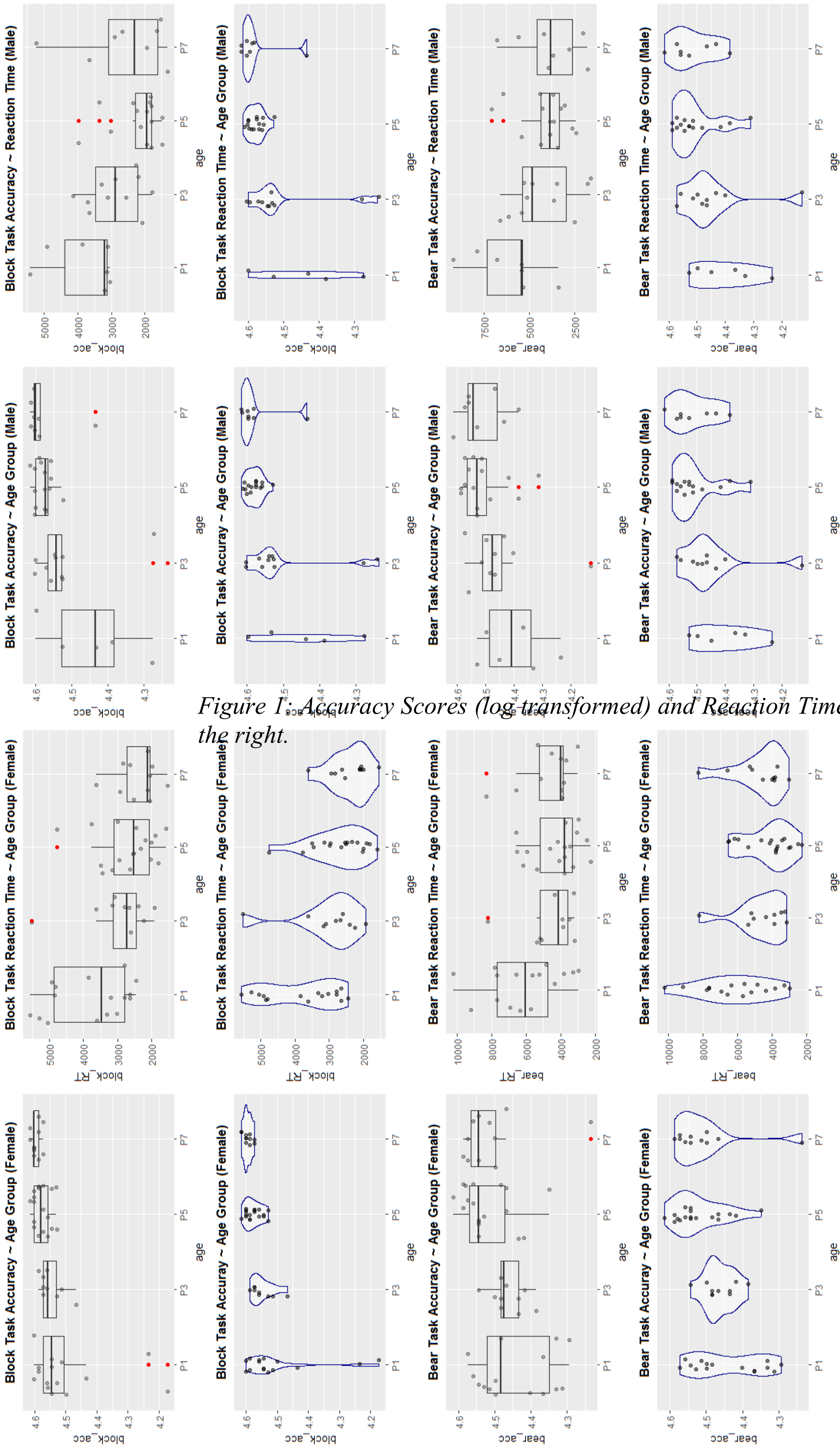


Figure 1: Accuracy Scores (log transformed) and Reaction Times (ms) for both Block an the right.

n Both Block and Bear Spatial Awareness Tasks split by Gender and Age

	Boys								Girls							
	P1		P3		P5		P7		P1		P3		P5			
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean
cc	75.6	18.0	89.8	10.4	96.5	2.2	96.7	5.5	87.4	13.7	89.9	12.0	96.1	2.6	98.0
RT	3807	971.94	2867	765.3	2197	708.6	2610	1320.5	3798	1097.7	2999	1009.34	2698	807.3	2399
c	75.6	16.5	80.8	17.9	90.2	6.9	90.6	7.1	82.1	11.5	85.8	4.0	91.2	6.3	90.2
T	6187	1913.14	4218	1725.8	4108	1311.8	3842	1710.5	6138	2067.3	4585	1514.2	4214	1356.5	4741

ccuracy scores are shown in percentage. Reaction times are shown in milliseconds. N = 92 for block task accuracy (block_acc), N = 93 uracy (bear_acc). N = 97 for reaction times.

There were significant differences between bear and block task accuracy for both girls ($\beta = .52$, $p < .001$, $R^2 = .20$) and boys ($\beta = .52$, $p < .001$, $R^2 = .27$). In both cases, participants were better at the block condition. Similarly, there were significant differences between bear and block reaction times for both girls ($\beta = .54$, $p < .0001$, $R^2 = .29$) and boys ($\beta = .59$, $p < .0001$, $R^2 = .35$). Again, in both cases participants were better at the block condition.

No significant differences between genders for accuracy or reaction time on either task were found at any age. However, significant interactions (see Figure 2) between gender and age were seen for both bear task ($F(7, 88) = 3.55$, $p = 0.002$) and block task ($F(7, 88) = 5.27$, $p < 0.001$). As shown in Figure 2, interactions are significant due to crossover, however projections are the same for both boys and girls in that performance increases as age increases.

Gender Difference in Attitudes

Attitudes scores were considered both as an overall measure and split by factors. Table 2 shows means and standard deviations for both overall attitude and individual factor scores. Despite large range suggested in descriptive analysis of overall attitudes (Figure 3), there were no instances out with 2.96 standard deviations from the mean and therefore all observations were included in further analysis. Where pseudo R^2 is reported, value has been calculated using McFadden's pseudo-R^2 formula.

Overall Attitudes. Initial analysis suggested no significant difference between age groups for overall attitudes towards mathematics ($F(3, 93) = 1.472$, $p = .227$). Planned contrasts revealed a significant drop in attitudes between Primary 3 and Primary 5 ($F(3, 93) = 1.472$, $p = .049$) overall. When these contrasts were split by gender there were no significant differences shown at any stage for boys (P1 – P3; $F(3, 38) = .902$, $p =.578$: P3 – P5; $F(3, 38) = .578$, $p = .746$: P5 – P7; $F(3, 38) = 3.053$, $p = .609$). For the female data there was a significant drop in attitudes at each age group (P1 – P3; $F(3, 51) = 3.053$, $p = .00378$: P3 – P5; $F(3, 51) = 3.053$, $p = .02828$: P5 – P7; $F(3, 51) = 3.053$, $p = .00566$). When looking at gender differences, there was a significant difference in overall attitudes scores ($\beta = -.91$, $p = .0416$, pseudo-$R^2 = .291$), where girl's attitudes are lower than boy's attitudes. When this analysis was split by age group, it became apparent that this disparity in attitudes only becomes significant at Primary 7 ($b = -3.10$, $p = .0192$, pseudo-$R^2 = .291$). Significant interaction between gender and age was found for overall attitudes ($F(7, 89) = 2.89$, $p = .0282$), where boys showed an increase in raw attitude scores and girls showed a decrease over time. Gender was found to be a significant predictor ($F(1, 89) = 4.874$, $p = .0298$) but age was not ($F(3,89) = 1.945$, $p = .1281$). See Figure 4 for all interaction plots relating to this research question.

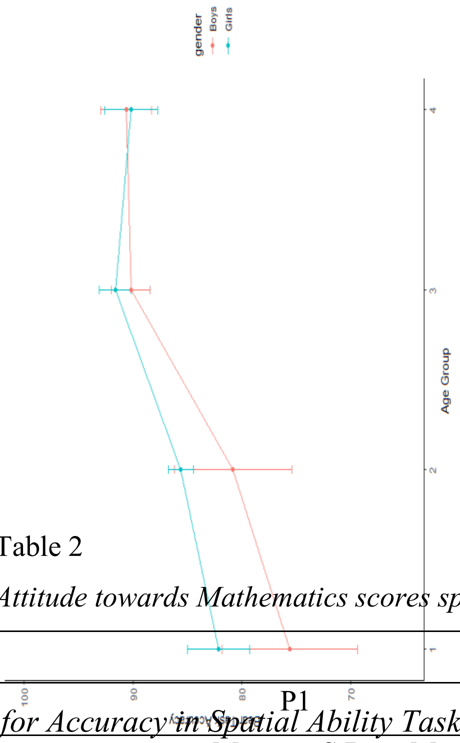


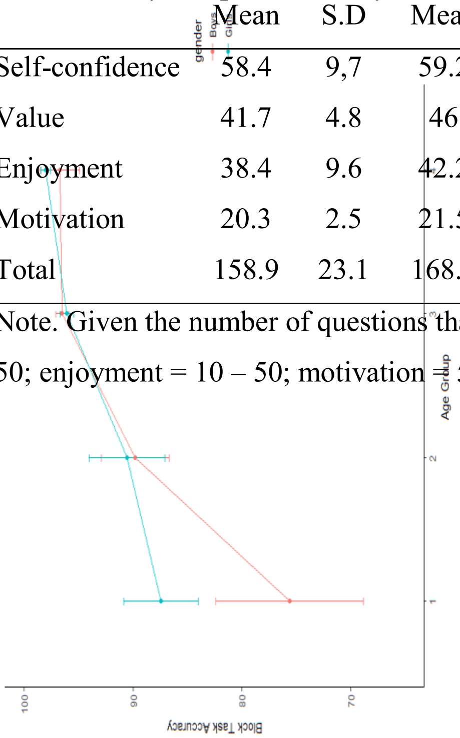
Table 2

Attitude towards Mathematics scores split by Gender and Age

	Boys								Gi			
	P1		P3		P5		P7		P1		P3	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Self-confidence	58.4	9,7	59.2	9.5	57.3	8.4	62.4	11.2	58.3	9.2	53.4	12.4
Value	41.7	4.8	46	3	40.5	7.5	42.4	5.7	43.2	5.4	42	7.9
Enjoyment	38.4	9.6	42.2	4.2	38.9	7.8	39.6	7	42.6	4.7	34.9	7.4
Motivation	20.3	2.5	21.5	3.3	19.4	4	22.4	2.8	20.9	2.4	19.8	3
Total	158.9	23.1	168.8	14.8	156.2	24.2	166.9	24.1	165	15.3	150.1	27.5

Note. Given the number of questions that load onto each factor, possible ranges for each factor is as follows: self-confic 50; enjoyment = 10 – 50; motivation = 5 – 25; total attitude score = 40 – 200.

teraction Plots for Accuracy in Spatial Ability Tasks. Inter t standard



Mathematics Enjoyment. There was a significant difference between girls and boys shown for mathematics enjoyment (F(3, 93) = 3.053, p = .0323, η = .09). Planned contrasts revealed significant differences between each age group for girls (P1 – P3; F(3, 51) = 7.861, p < .001: P3 – P5; F(3, 51) = 7.861, p = .00573: P5 – P7; F(3, 51) = 7.861, p = .00221). No significant differences apparent at any age group for boys (P1 – P3; F(3, 38) = 7.183, p = .551: P3 – P5; F(3, 38) = 7.183, p = .648: P5 – P7; F(3, 38) = 7.183, p = .915). When mathematics enjoyment was analysed looking for gender differences at each age group, the differences between boys and girls only became significant at Primary 7 (b = -3.02, p = .223). Both gender (F(1, 89) = 4.734, p = .03222) and age (F(3, 89) = 4.011, p = .00998) are significant predictors in mathematics enjoyment. A significant interaction between gender and age (F(7, 89) = 3.663, p = .01532) was found. Interaction plots (Figure 4) show that boys' mathematics enjoyment remains fairly stable throughout primary school, whereas girls' mathematics enjoyment shows a decrease over time.

Mathematics Self-Confidence. No significant difference between age groups was apparent in initial analysis. However, when this analysis was split for gender there was a significant drop in self-confidence between Primary 1 and Primary 3 (F(3,51) = 2.523, p = .0422) and again between Primary 5 and Primary 7 (F(3,51) = 2.523, p = .0236) for the girl's data. No differences were seen in the boy's data (P1 – P3; F(3, 38) = .5487, p = .76: P3 – P5; F(3, 38) = .5487, p = .726: P5 – P7; F(3, 38) = .5487, p = .263). When looking at gender disparity, significant differences between boys and girls were not apparent until Primary 7 (b = -3.33. p = .023). Gender proved to be a significant predictor of self-confidence scores (F(1, 89) = 5.943, p = .0168). There was no effect of age (F(3, 89) = .877, p = .456), and no interaction between gender and age was found (F(3, 89) = 2.447, p = .0883).

Mathematics Motivation. A significant difference between Primary 5 and Primary 7 was seen for the girls' data (F(3, 51) = 2.02, p <.05), but no significant differences between year groups were seen within the boys' data (P1 – P3; F(3, 38) = 1.772, p = .564: P3 – P5; F(3, 38) = 1.772, p = .962: P5 – P7; F(3, 38) = 1.772, p = .115). There was no significant difference between genders until Primary 7 (b = -3.10, p = .017). Within the interaction models, neither gender (F(1, 89) = 1.004, p = .3191) nor age (F(3, 89) = 0.38, p = .7679) are significant predictors of mathematics motivation, however there was a significant interaction shown (F(3, 89) = 3.482, p = .0191). Interaction plot (Figure 5) shows that over time, boys' mathematics motivation increases whereas girls' motivation decreases.

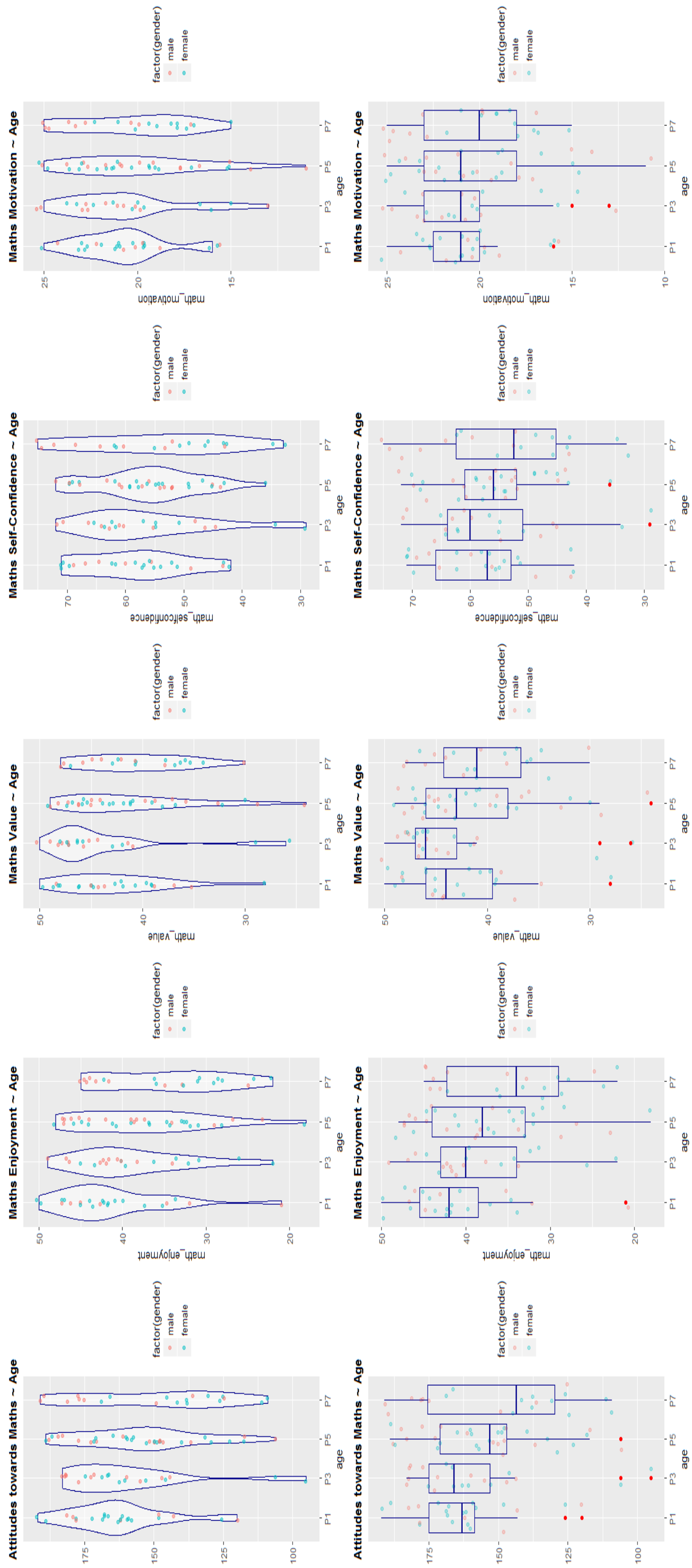
Mathematics Value. Planned contrasts revealed a significant difference in mathematics value between Primary 3 and Primary 5 for the overall data (F(3, 93) = 1.7, p <

.05). When these contrasts were split by gender, there were no significant differences shown for either boys (P1 – P3; $F(3, 38) = 1.971$, $p = .597$: P3 – P5; $F(3, 38) = 1.971$, $p = .208$: P5 – P7; $F(3, 38) = 1.971$, $p = .89$) or girls (P1 – P3; $F(3, 51) = 1.185$, $p = .1856$: P3 – P5; $F(3, 51) = 1.185$, $p = .1654$: P5 – P7; $F(3, 51) = 1.185$, $p = .0966$). Additionally, there were no significant differences between the genders at any age (P1; ($b = .62$, $p = .522$): P3; ($b = -1.817$, $p = .193$): P5; ($b = .391$, $p = .58$): P7; ($b = -1.532$, $p = .144$)). There was no interaction found between gender and age for mathematics value ($F(3,89) = 1.486$, $p = .224$) and neither age ($F(3,89) = 1.709$, $p = .171$) nor gender ($F(1,89) = .598$, $p = .441$) proved to be significant predictors.

How Attitudes influence Ability

For this section of analyses, accuracy scores were split into factors of high performance, middle performance and low performance. These cut offs were taken from the interquartile ranges. Cutting at these points were chosen to account for skewed data – as previously discussed.

Analysis to look at whether attitudes predicted ability were run for all ages, both genders and across attitude factors. There were significant differences in overall attitudes between accuracy groups for Primary 1 boys in the bear task ($F(1,4) = 9.7$, $p = .0357$)), where higher overall attitude scores related to lower task accuracy. There were significant differences in mathematics value between accuracy groups for Primary 1 boys ($F(1,4) = 27.04$, $p = .00652$)) and for Primary 1 girls ($F(2,12) = 4.649$, $p = .032$)) in the bear task. Interestingly, higher mathematics value related to lower bear task accuracy for boys, whereas higher mathematics value related to higher bear task accuracy for girls. Additionally, there were significant differences in block task accuracy groups and mathematics enjoyment for Primary 3 girls ($F(1, 7) = 7.875$, $p = .263$), where higher maths enjoyment related to higher accuracy scores. No other predictors were significant at any age group. In conjunction with this, ability in either the block or bear task was not indicative of future job aspirations for either girls or boys at any age group. For full results relating to this section see Appendix B.



ıg Attitude Scores overall and b

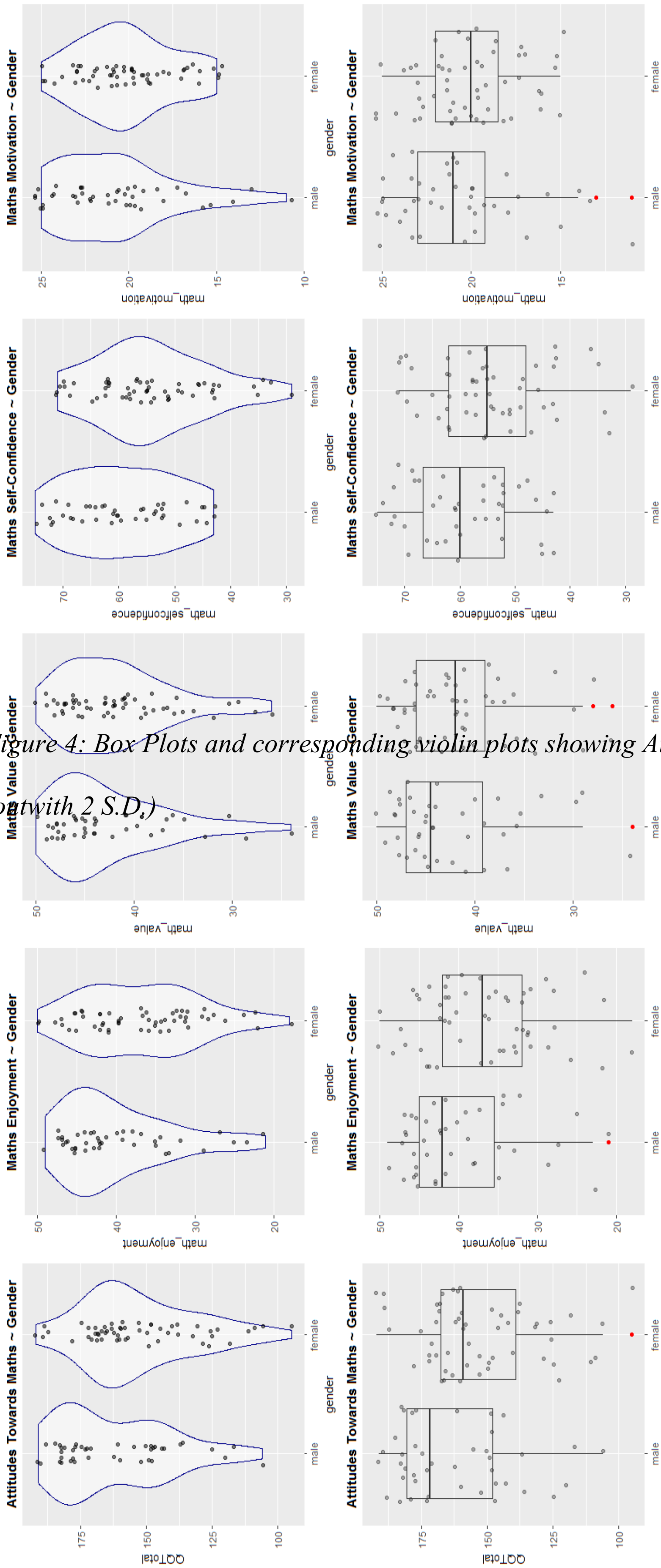


Figure 4: Box Plots and corresponding violin plots showing Attitude Scores overall and by factor sp

(outwith 2 S.D.)

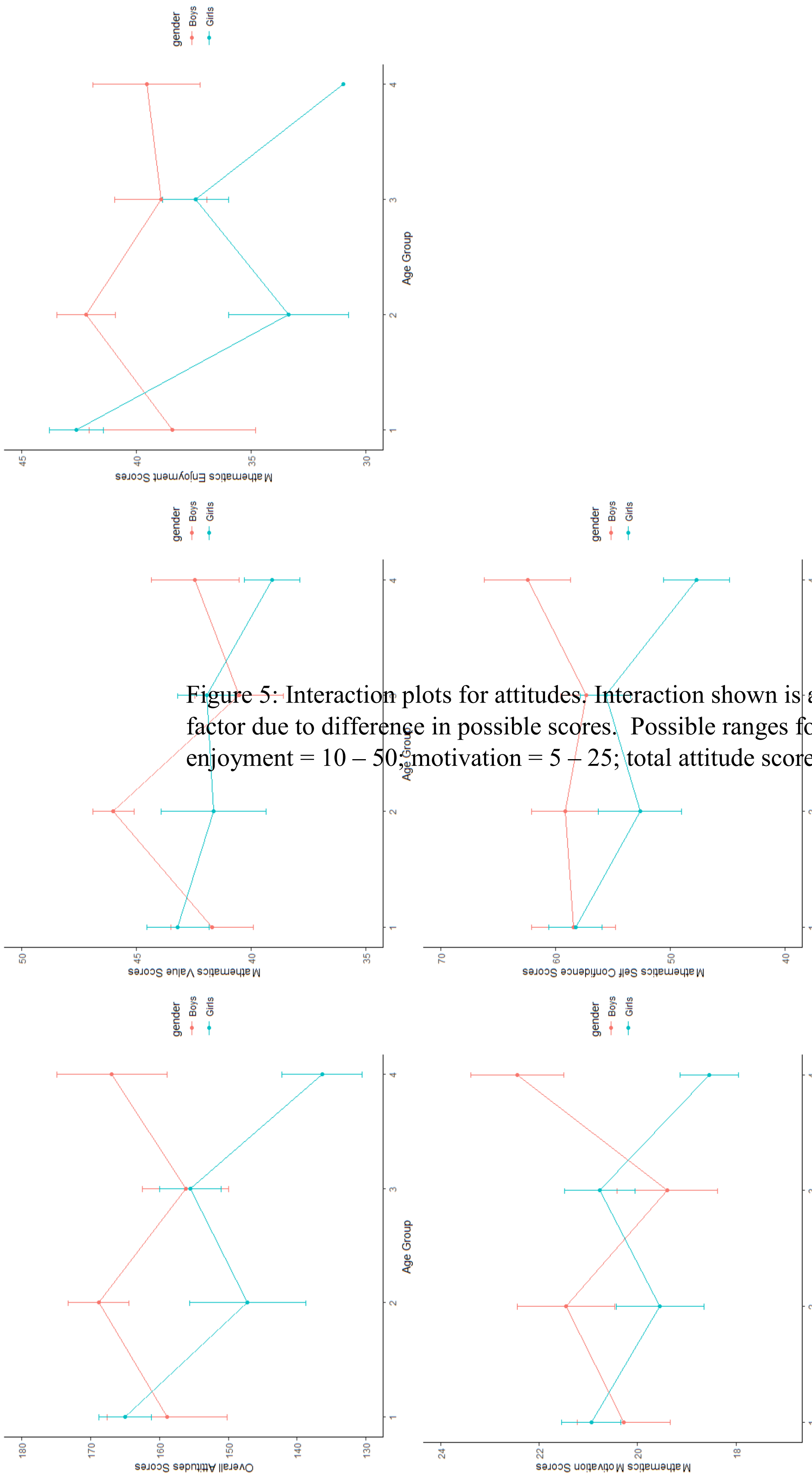


Figure 5: Interaction plots for attitudes. Interaction shown is age*gender. Error bars depict
factor due to difference in possible scores. Possible ranges for each factor is as follows: se
enjoyment = 10 – 50; motivation = 5 – 25; total attitude score = 40 – 200.

Additional Factors for Consideration

Teachers. Teacher gender showed no significance for either ability or attitudes. Teacher gender was only analysed in the year group where there was both male and female teachers. Specific teacher did show to be a significant predictor of Primary 1 girls' mathematics enjoyment (F(1, 14) = 4.748, p = .047)) and of Primary 5 girls' mathematics motivation (F(1, 14) = 7.296, p = .0164)). However, the individual teacher had no relationship towards children's future job aspirations.

Parents. Descriptive analysis suggested that girls who had a parent who was at home had better attitudes towards mathematics on average, and that boys with dads in STEM had higher attitudes than the rest of their peers. Given this suspected outline, post hoc contrasts were run differentiating parents at home and parents in STEM, in addition to analysis by overall age and gender (in concordance with analysis run above). Primary 1 girls with working mothers performed significantly higher on the block task ($F(1,13) = 6.36$, $p = .0082$)). Additionally, Primary 3 girls whose mothers work in life sciences showed significantly lower scores for mathematics motivation ($F(2,8) = 15.77$, $p = .00168$)). Primary 1 boys whose fathers work in STEM performed significantly better in the bear task paradigm ($F(1, 4) = 8.658$, $p = .0423$)). Primary 1 boys with fathers working in STEM showed significantly lower mathematics value scores ($F(1, 5) = 7.68$, $p = .0393$)). Conversely, Primary 1 girls whose fathers work in STEM showed higher scores for mathematics enjoyment ($F(4, 11) = 3.592$, $p = .0415$)). Concordantly, Primary 3 girls whose fathers work in STEM showed significantly higher mathematics value ($F(2, 8) = 6.372$, $p = .02$)). No other predictors showed significance, for full results relating to this section, see Appendix C.

Discussion

Gender Differences in Ability

There was no gender difference seen for either spatial awareness task at any age group. This would suggest that, contrary to previous research, there is no innate male bias towards mental rotation. Interestingly, there was also no difference between the two tasks. This was unexpected as it goes against the toy hypothesis (Schug, 2016). It could be that the tasks were not similar enough in difficulty, and this has led to not seeing a difference. It could also be that there simply is no difference to be seen. It would be prudent in future research to find out how often each participant engages in spatial ability type tasks – i.e. playing with Lego (as in Oostermeijer et al, 2004) – to further analyse whether practice and familiarity is a significantly contributing factor.

It would be beneficial to accompany the current research with other measures of mathematic ability – such as computation or pattern recognition – to look at the relationships between these different types of tasks. If it is assumed that spatial ability is an accurate predictor of mathematic ability, the findings of the current study have a huge impact on female STEM involvement. Girls may not think they are successful at mathematics; however, this research suggests that this is not the case, implying that the lack of women's uptake is due to attitudes and not to academic potential.

Gender Differences in Attitudes

In terms of attitudes, there was a consistent report of girls' scores decreasing across age groups, whereas boys' scores stayed the same or increased, as expected from previous research (e.g. Halpern et al, 2007) When analysed by factors, there was no difference between girls and boys for mathematics value. Suggesting that all children are aware that mathematics is important, but there are male favoured differences in effort, confidence in abilities, and enjoyment within mathematics classes. The divide between girls and boys became apparent at Primary 7. For self confidence in girls, there was a significant drop between Primary 1 and Primary 3, and again between Primary 5 and Primary 7, whereas boys increased over time, with no significant differences between age groups. Overall attitudes for girls showed a significant drop at each age group, whereas attitudes for boys increased overtime with no significant differences between age groups. Mathematics enjoyment showed significant difference at every age group for both boys and girls, with girls' enjoyment decreasing and boys' increasing overall. Mathematics motivation showed the same pattern. These results show that girls and boys start with positive attitudes towards mathematics (often with girls beginning with a higher average scores), but also that by the end of Primary 7 girls are at a significant disadvantage in comparison to boys. Especially considering that for both motivation and self-confidence scores, the children in this data set scored within the top half of the range of possible scores, and a significant difference between genders remains apparent. From this, intervention towards mathematics attitudes, and subsequently STEM involvement, is required far earlier than previously envisaged. Previous research into the ATMI focusses primarily on validity of the factors (Lim & Chapman, 2013; Afari, 2013; Ngurah & Lynch, 2013) whereas the current research assesses how individual factors relate to gender disparity in attitudes towards mathematics over time.

How Attitudes influences Ability

Lower scores in overall mathematics attitudes and mathematics value significantly predicted higher task performance in Primary 1 boys. Conversely, higher scores in mathematics value and mathematics enjoyment significantly predicted higher task performance in Primary 1 and Primary 3 girls respectively. No other measures of mathematics attitudes proved significant. It is of particular interest that the relationship between attitudes and ability is converse in girls and boys. It is possible that this is a non-replicable finding of the current data set. However, the significant results for mathematics value suggests that this factor may play a key role in the development of overall mathematics attitudes. Given that mathematics anxiety is more common in girls (Geist, 2015), it is logical that understanding that mathematics is important may lead to further apprehension regarding mathematics performance. Further research obtaining information as to what drives mathematics value understanding and development is required.

While previous research has established that attitudes affect performance (such as Cargnelutti et al, 2016), interpreting at which stage of the education system this phenomenon becomes apparent would be crucial for future research. In which case, extending the current study throughout primary and secondary schools would allow researchers to investigate this line of enquiry.

Additional Factors for Consideration

Given the above pattern of results, it was necessary to look at additional factors that may have contributed to the stark differences between boys and girls. Within this study, individual teachers and parent's occupations were chosen. The current research saw no difference between teacher genders – however post-hoc power analysis suggests there simply isn't enough data for this result to be conclusive. Individual teacher showed significance for mathematics motivation in Primary 5 and mathematics enjoyment in Primary 1 for girls only. This is important as the influence of individual teachers only appears to be significant for girls in this particular cohort. It was expected that parent's occupation would influence attitudes, however previous research in this field tends to focus on older children (Ing, 2014). Parents' occupations proved significant across a number of factors. Primary 1 girls with working mothers scored significantly higher in the block task. Primary 3 girls whose mothers work in life sciences scored significantly lower in mathematics motivation. Primary 1 boys whose fathers work in STEM performed significantly better in the bear task, but showed significantly lower scores in mathematics value. Conversely, girls whose fathers work in STEM showed significantly higher scores in Primary 1 for mathematics enjoyment, and in Primary 3 for mathematics value. There is no previous research that analyses gender differences between the individual factors of the ATMI, and the implications of these differences in conjunction with other factors of STEM inclusivity. Given this, the reasons for the above results are unclear. It appears that a positive STEM role model is beneficial for girls predominantly. It is particularly interesting that the pattern of results is converse between girls and boys, such as Primary 3 boys showing lower scores in mathematics value where girls show higher mathematics value when fathers are employed in STEM. However, pattern of results did not hold across age groups. It could be that these factors are only beneficial in shaping attitudes and that could be why significant results are found in the younger age groups, or the results could be an artefact of the data unique to this dataset. It would be beneficial to give both teachers and parents the same questionnaire as the children to see whether attitudes towards mathematics transferred or influenced pupil's attitudes (as is suggested in (Beilock et al, 2010)) and at which ages this occurs. Another angle of future research could be to look at implicit biases of teachers. For example, to look at children's report cards for mathematics and look at the differences in language between girls and boys.

Limitations & Future Directions

This study only looked at children from one school in Scotland. Given this limited sample, it would be unwise to generalise these findings on their own. It would be beneficial to look that this paradigm on a wider scale, across Scotland in both rural and city areas to determine whether this pattern of results is consistent throughout the country. It would also be interesting to look at different areas world-wide to see whether specific education systems in countries that are more inclusive in their representations of women in STEM, or in countries where women are a larger proportion of the STEM workforce exhibit the same patterns.

Additionally, this school is engaged in many intervention methods and adhering to recommendations for improving STEM attitudes. For example, they are enrolled in Young Engineers (Institute of Primary Engineers, 2016) and have a dedicated 'Science Week' where women are giving talks about science to the younger years. It is important to note this because if this school is seeing attitude differences despite doing active interventions – what is happening at the schools who do not? It would be prudent to look at what intervention methods are currently available within the Scottish curriculum and assess which methods are contributing to improved attitudes, particularly for girls. Discussions with 'Primary Engineer', 'Science Ceilidh' and 'Sum Dog' suggest that longitudinal analysis of their individual programs and ways of targeting interventions towards women are future directions for each of the companies, but are not currently a focus for them.

Given the year group (P7) that showed the most difference between girls and boys attitudes, it is likely that wider societal factors and media portrayal of women in STEM has some effect. Not only is this the age group where children start developing their own sense of self, it is also the age where children begin to have access to private electronic devices with easy internet access. Within the classroom we can begin to gender-neutralise both our teaching and our representation of STEM. Given that the above research suggests that attitudes do play a key role, gender targeted teaching for girls towards STEM – and equally boys towards the arts – will also contribute to dispelling the myth that either gender are “meant” to fit a particular societal role. While we do need to be looking at what can be done within the education sector, it is equally important to address the wider negative image of women in our society. Research into parent’s attitudes will help to explore what obstacles are faced in the home but if little girls never see women as scientists they will never see themselves as scientists. These interventions lie within the media, where women should be represented in magazines, textbooks, adverts etc. in roles within STEM fields.

Overall, a much larger sample of the current study would determine if the pattern of results is consistent across the country. Addition of teachers’ and parents’ attitudes, school participation in STEM interventions, and information on internet access/possession of mobile devices would help to look further into factors that contribute to attitudes towards mathematics. Longitudinal studies into intervention methods specifically would validate the interventions themselves and highlight which methods are helping to improve attitudes and close the gender gap. Longitudinal data would also benefit research into spatial abilities and how they feed into mathematics performance. It has been posited in this paper that positive attitudes towards mathematics will feed into positive attitudes towards science, and eventually science success – a claim that would be explored further if participants were followed up through primary and secondary school.

Conclusion

The current research acted as a pilot study for a future wider project encompassing mathematics abilities and attitudes, outside influences on primary school aged children, and how these factors mesh together to further understanding of our lack of women in STEM. The inclusion of the above multiple factors aims to aid a future study across Scotland and educate researchers on the factors that should be included when investigating, particularly, children’s attitudes towards STEM. This study added to the body of research confirming that there is no biological or innate advantage towards males in terms of mental rotation. However stark differences in attitudes towards mathematics are clear from an early age. This study has identified that prior to a significant gender divide at Primary 7, there is a significant drop in girl’s attitudes occurring between Primary 3 and Primary 5. This is important for several reasons. Firstly, it explicitly shows that intervention methods for mathematics, and wider

STEM participation, is required far earlier than secondary school. It allows us to see at which age groups intervention should be targeted and analysis of individual factors showed which areas of mathematics need to be targeted at each age group. Significant results in terms of teachers and parents suggests further research is required to look at factors which influence children's attitudes – including media stereotypes and portrayal of women in science in our society. Additionally, how specific factors of mathematics attitudes affect performance and wider STEM participation. Ideally, the societal aim is to fully understand a paradigm in which we are empowering children, benefitting them to pursue their chosen interests without anxiety or negativity, to the greatest of our capability.

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Appendix A

Modified ATMI Questionnaire

1	Maths is a useful subject I need to learn	
2	I want to get better at maths	
3	I really like solving problems	
4	Maths helps me to think more about other things	
5	Maths is very important in everyday life	
6	Maths is the most important subject for me to learn	
7	Being good at maths will be helpful no matter what job I want when I grow up	
8	I can think of ways maths is useful outside of my classroom	
9	I really do not like maths	
10	Sometimes I can't think properly when I see numbers	
11	Doing maths makes me feel nervous	
12	Seeing numbers make me feel uncomfortable	
13	I find being in maths classes very hard work	
14	When I hear the word 'maths' it makes me feel sad	
15	I don't like the thought of having to do maths	
16	Mathematics doesn't scare me at all	
17	I think I am good at maths	
18	I am able to try solving problems without much difficulty	
19	I think I would do well in a maths test	
20	I am confused in maths	
21	I don't think I am very good at trying new maths problems	
22	I learn maths easily	
23	I think I could be good at maths when I go to high school	
24	I enjoy studying maths at school	
25	Maths is boring	
26	I like trying new problems in maths	
27	I would prefer maths homework to writing homework	
28	I would avoid maths classes if I could	
29	I really like maths	
30	I am happier in maths classes than in my other classes	
31	Maths is interesting	
32	I would do more maths happily if I was asked to	
33	I want to do more maths when I am in high school	
34	I like that maths can sometimes be a challenge	
35	I think studying maths is useful	
36	I think being good at maths would make being good at other subjects easier	
37	I am happy to answer questions in maths classes if the teacher asks me	
38	I like to tell people my own ideas about maths	
39	Being good at maths will help me get a good job when I grow up	
40	I think I am good at solving maths problems	

Appendix B

Full Results for How Attitudes influence Ability

Table B4: *ANOVA results - Attitudes and accuracy in Block Task*

	Girls										
	P1		P3		P5		P7		P1		
	F	p	F	P	F	p	F	p	F	P	F
Overall Attitudes	2.16	.16	1.95	.2	1.84	.19	.44	.52	.17	.71	1.0
Motivation	.78	.47	.8	.47	1.33	.29	1.63	.27	.04	.86	.8
Enjoyment	.65	.54	7.86	.03*	2.54	.11	.26	.62	.58	.5	.0
Value	.34	.72	1.8	.22	1.04	.38	.044	.84	.41	.57	.0
Self Confidence	2.02	.18	.35	.57	.48	.63	.52	.49	4.6	.12	3.3

N.B. For both Tables 4 and 5. *p < .05. **p < .01. Both F and p values have been rounded to 2

ttitudes and accuracy in Bear Task

Girls									
P1		P3		P5		P7		P1	
	p	F	p	F	p	F	p	F	p
2	.24	.95	.36	2.17	.15	2.46	.15	9.7	.04*
	.55	.45	.52	3.42	.06	1.52	.28	7.2	.06
3	.21	2.02	.19	.842	.45	2.86	.12	2.23	.21
5	.03*	.79	.4	.79	.47	.87	.45	27.04	.007**
	.64	.90	.37	2.36	.13	2.68	.13	7.08	.06

Appendix B (continued)

Full Results for How Attitudes influence Ability

A Results - Ability in Block Task and future Job Aspirations

	Girls								Boys							
	P1		P3		P5		P7		P1		P3		P5		P7	
	F	p	F	p	F	p	F	p	F	p	F	P	F	p	F	p
	1.02	.39	2.03	.2	.81	.46	.01	.94	9.03	.06	.22	.81	1.01	.4	.14	.88
	.64	.54	.02	.9	.63	.55	.09	.77	8.07	.06	.01	.99	.04	.97	.57	.6

o values have been rounded to 2.d.p. where necessary

Appendix C

Full Results for Additional Factors to Consider

ble C6: *GLM Results – Teacher Gender and Measures of Ability, Attitudes and Future Job Aspirations*

	Girls		Boys	
	b	p	b	p
Block Task Accuracy	-.68	.64	.16	.9
Bear Task Accuracy	-1.37	.36	1.97	.32
Overall Attitudes	.09	.95	1.44	.28
Math Motivation	-3.49	.14	.54	.67
Math Enjoyment	-.17	.9	3.26	.15
Math Value	.22	.86	-2.83	.15
Math Self Confidence	.33	.8	1.78	.21
Job Aspiration: Non STEM	-.42	.48	-5.56	.99
Job Aspiration: Life Sciences	-.42	.75	-5.56	.99
Job Aspiration: STEM	NA	NA	14.93	.99

B. All values have been rounded to 2.d.p. where necessary. Analysis carried out on Primary 3 data only. NA – no primary 3 girls showe erest in STEM for future job aspirations, and so level was dropped from analysis.

Appendix C (continued)

Full Results for Additional Factors to Consider

le C7: *ANOVA and Chi Square results - Individual Teacher and Measures of Ability, Attitudes and Future Job Aspirations*

	Girls								Boys							
	P1		P3		P5		P7		P1		P3		P5		P7
	F	p	F	P	F	p	F	p	F	P	F	P	F	P	F
Block Task Accuracy	.01	.93	.18	.68	.1	.91	1.89	.2	.41	.57	.01	.91	.08	.92	.97
Bear Task Accuracy	.05	.83	.8	.4	.9	.43	2.5	.15	1.1	.36	1.4	.27	.71	.51	.2
Overall Attitudes	.03	.87	.003	.96	2.32	.13	.63	.45	.8	.41	1.17	.31	.62	.55	.55
Math Motivation	.02	.9	3.74	.09	7.3	.02*	.68	.43	.28	.62	.16	.7	.75	.49	1.65
Math Enjoyment	4.75	.047*	.28	.61	.12	.74	2.15	.18	.18	.69	3.79	.08	.86	.45	.19
Math Value	1.33	.27	.002	.97	.002	.97	.01	.94	.18	.69	3.17	.11	.97	.41	1.21
Math Self Confidence	.4	.54	.006	.94	2.2	.16	.43	.53	3.99	.1	1.71	.22	.84	.46	.28
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2
Job Aspiration	3.56	.17	NA	NA	NA	NA	.86	.35	NA	NA	1.4	.5	2.54	.64	1.44

. *p < .05. F, $\chi 2$ and p values have been rounded to 2.d.p. where necessary Where data is insufficient, analysis has not been ried out (NA)

Appendix C (continued)

Full Results for Additional Factors to Consider

able C8: *ANOVA and Chi Square results - Mother's Occupation and Measures of Ability, Attitudes and Future Job Aspirations*

	Girls								Boys							
	P1		P3		P5		P7		P1		P3		P5		P7	
	F	p	F	P	F	p	F	p	F	P	F	P	F	P	F	p
Block Task Accuracy	6.36	.008**	.58	.58	.17	.92	.22	.88	.76	.45	.36	.78	.3	.87	.08	.9
Bear Task Accuracy	1.69	.23	.11	.9	.66	.59	.07	.97	.42	.81	.36	.78	1.21	.37	.5	.
Overall Attitudes	1.62	.24	1.93	.21	1.73	.21	.34	.8	.33	.84	.27	.85	1.21	.37	.5	.
Math Motivation	.35	.84	15.77	.002**	2.49	.11	1.46	.31	1	.56	.62	.62	.82	.54	.26	.8
Math Enjoyment	1.82	.2	.36	.71	1.32	.31	.37	.78	.62	.69	.46	.72	.33	.86	.53	.6
Math Value	.9	.5	1.31	.32	.75	.54	.24	.87	.17	.94	1.05	.43	2.14	.15	.31	.8
Math Self Confidence	1.08	.41	4.12	.06	1.29	.32	.24	.87	.21	.91	.75	.56	1.86	.2	.78	.5
	χ^2	p	χ^2	P	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Job Aspiration	5.46	.71	NA	NA	2.93	.23	NA	NA	9.33	.32	2.36	.88	11.31	.18	5.6	.4

.B. * $p < .05$, ** $p < .01$. F, $\chi 2$ and p values have been rounded to 2.d.p. where necessary. Where data is insufficient, nalysis has not been carried out (NA)

Appendix C (continued)

Full Results for Additional Factors to Consider

able C9 : *ANOVA and Chi Square results - Father's Occupation and Measures of Ability, Attitudes and Future Job Aspirations*

	Girls								Boys							
	P1		P3		P5		P7		P1		P3		P5		P7	
	F	p	F	P	F	p	F	p	F	P	F	P	F	P	F	p
Block Task Accuracy	1.48	.28	1.38	.31	1.5	.26	2.01	.2	2.18	.24	.69	.59	.69	.61	1.82	.2
Bear Task Accuracy	.46	.77	.28	.76	1.36	.3	.28	.76	8.66	.04*	.2	.89	2.51	.11	.95	.4
Overall Attitudes	2.47	.11	2.57	.14	1.41	.29	1.96	.2	1.19	.33	.24	.87	.43	.79	1.61	.2
Math Motivation	.39	.81	.19	.83	.39	.76	2.83	.12	.39	.56	1.54	.29	.85	.53	.73	.5
Math Enjoyment	3.59	.04*	.99	.41	.42	.74	1.77	.23	.44	.54	.61	.63	.29	.88	1.47	.
Math Value	.6	.67	6.37	.02*	2.5	.11	3.19	.1	7.68	.04*	.26	.85	.49	.74	.3	.7
Math Self Confidence	2.35	.12	2.55	.14	2.77	.08	.92	.44	.54	.5	.24	.87	.96	.47	2.2	.1
	χ^2	P	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Job Aspiration	9.52	.3	.36	.84	2.56	.86	.92	.63	NA	NA	4.63	.59	4.63	.8	4.44	.3

.B. * p < .05. Both F and p values have been rounded to 2.d.p. where necessary. Where data is insufficient, analysis has not een carried out (NA)